

Sustaining Nuclear Generation

**Exelon Perspective Presented to
Illinois Commerce Commission**

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Exelon Generation.[®]

Exelon Long-Term View of US Nuclear Industry

- ✓ Preserve the existing fleet
 - 96 reactors in operation
 - Provided 19.3% of total US electric generation and over 55% of country's emissions-free electricity in 2018
 - Achieved 92.3% average capacity factor in 2018
- ✓ Support development of light-water small modular reactors (SMRs) and advanced reactors for commercial deployment

Momentum of current fleet is needed to ensure commercial viability of next generation of SMRs and advanced reactors

Illinois' Nuclear Fleet Provides Resilient, Reliable, Low-Cost and Carbon-Free Energy

- ✓ Illinois' nuclear plants are the reason that it has one of the lowest electricity rates in the nation and produces more clean energy than any other U.S. state.
- ✓ Illinois has the largest nuclear fleet in the U.S., with 11 operating nuclear units at 6 power stations, which collectively produce more zero-emission energy than any other state.
- ✓ Exelon's nuclear plants:
 - Produce more than half of Illinois' total electricity and **92% of its carbon-free power**
 - Generate enough electricity to power more than **11 million** homes and businesses
 - Provide one of the **lowest-cost** baseload sources of electricity available today
 - Supply **8 times** more carbon-free power than all Illinois wind and solar farms combined
 - **Operate around the clock**, and are **reliable** during extremes of heat and cold that severely limit other sources of electric power

Premature Nuclear Plant Closures/Shutdowns

| Plant | MWe | Closure Year | Reason |
|---------------------|-------------|--------------|-----------------|
| Crystal River 3 | 860 | 2013 | Economic |
| San Onofre 2 & 3 | 2,150 | 2013 | Policy/Economic |
| Kewaunee | 566 | 2013 | Market |
| Vermont Yankee | 620 | 2014 | Market |
| Fort Calhoun | 478 | 2016 | Market |
| Oyster Creek | 625 | 2018 | Policy |
| Pilgrim | 678 | 2019 | Market |
| Three Mile Island 1 | 803 | 2019 | Market |
| TOTAL | 6780 | | |
| Davis-Besse | 908 | 2020 | Market |
| Duane Arnold | 619 | 2020 | Market |
| Indian Point 2 & 3 | 2,061 | 2020-2021 | Market & Policy |
| Beaver Valley 1 & 2 | 1,872 | 2021 | Market |
| Perry | 1,268 | 2021 | Market |
| Palisades | 789 | 2022 | Market |
| Diablo Canyon 1 & 2 | 2,240 | 2024-2025 | Policy |
| TOTAL | 9757 | | |

Already Retired: Enough carbon-free energy to power 6.7 million homes and businesses

Closures Announced: Enough carbon-free energy to power 9.7 million homes and businesses

Exelon Efforts to Preserve Current Fleet

- ✓ Uphold safe operation
- ✓ Implemented power uprates and license renewal
- ✓ Continue investment in long term asset management
- ✓ Pursue second license renewal
- ✓ Reduce Costs
 - Collaborate with operators through Delivering the Nuclear Promise
 - Implement Project Legacy
 - Foster innovation
- ✓ Continue state and federal level advocacy for policy changes

Overview of Advanced Reactors

- ✓ Promise lower operating costs due to breakthroughs with design and fuel
- ✓ Size categories of nuclear reactors:
 - Micro reactors (less than 10 MWe)
 - Small modular reactors (between 10MWe and 300MWe)
 - Large scale reactors (greater than 300MWe)
- ✓ Reactor type categories of reactors
 - Light-water cooled
 - Molten salt
 - High Temperature
 - Fast
- ✓ Expected Commercialization dates of advanced reactors range from 2020's through early 2030's

Current Scenario for Light Water SMRs and Advanced Reactors

Concern over lack of US leadership in Nuclear Industry



Protection of National Security



Continued Need for Fuel Diversity



Concern over Environmental Trends



Platform for Action

GOVERNMENT RESPONSE

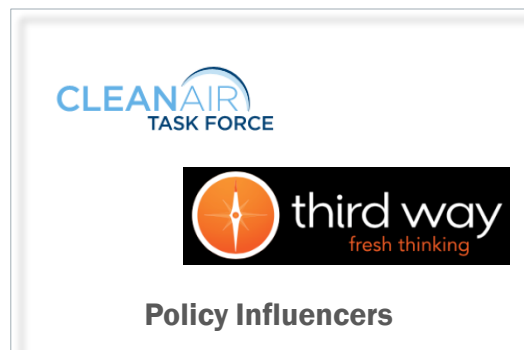
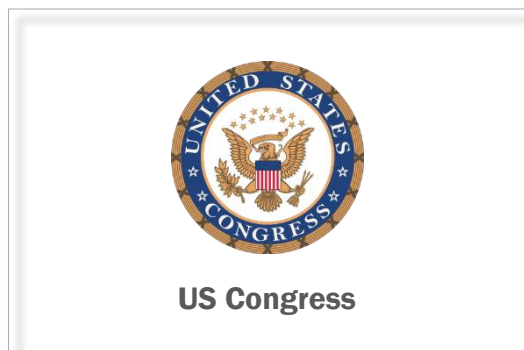
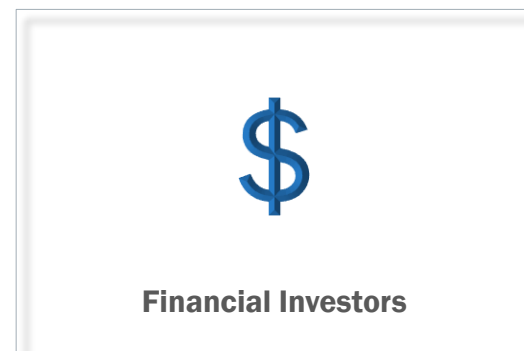
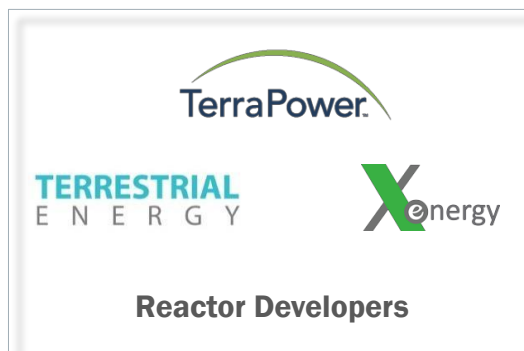
- Federal legislation
- Strong DOE support and leadership
- NRC funding and actions

INDUSTRY RESPONSE

- Increased activity by technology developers
- Availability of venture capital funding
- Coordination of industry initiatives

Recent years have shown an unprecedented interest in advanced reactors by industry, media, government and other stakeholders

Players Shaping Strategy



Current Objective and Execution Plan

Objective: Create and sustain long-term optionality for Exelon

Execution Plan:

1. Explore and evaluate opportunities with light water SMR and advanced reactor developers
2. Engage with internal and external stakeholders
3. Participate in industry forums to influence regulatory process and economic policy

Motivation for Exelon

- Influence future designs by providing operational perspectives
- Ensure available technology alternatives for the future
- Advance decarbonization of the energy sector to combat climate change
- Create business opportunities to provide operational services
- Communicate our long term commitment to nuclear to employees and external stakeholders
- Uphold our role as an industry leader

Proposed SMR and Advanced Reactor strategy is informed by the challenging environment currently surrounding Exelon's nuclear units and recognizes the need for the current fleet to sustain the manufacturing capability and talent pipeline

Reactor Technology Evolution

Light Water Reactors (LWR)



Existing
fleet

Passive LWR



LWR Small Modular Reactors (SMR)



Developers
Westinghouse
GE-Hitachi

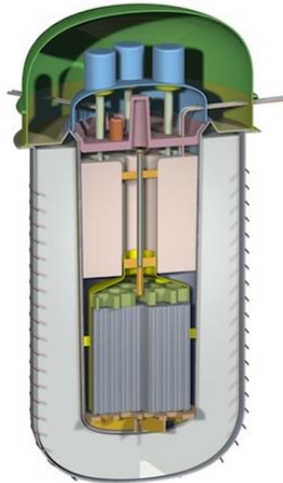
Developers
GE-Hitachi
NuScale
Holtec

Fusion Reactors



Developers
Helion
Tri-Alpha
General Fusion
Lockheed Martin
FusionOne

Molten Salt and Fast Reactors



Developers
Kairos
Terrestrial
TerraPower
Flibe
Elysium
Oklo
Westinghouse
UPower




High Temperature Gas-cooled Reactors (HTGR)



Developers
PBMR Ltd
Gen Atomics
Areva
Urenco
X-energy

SMR / Advanced Reactor Strategy Progress

Light Water SMR engagement

| Developer | Exelon Activity |
|---|---|
|  | ✓ Member of NuScale Advisory Board |
|  | ✓ Member of Holtec Advisory Council ✓ Signed MOU to provide support for design |
|  | ✓ Signed Project Support Agreement |

Internal and External stakeholder engagement

- Interface with numerous advanced reactor developers
- Member of NEI SMR Working Group and SMR Start
- Chair of NEI Advanced Reactor Working Group
- Member of NEI Microreactor Task Force
- Member of EPRI Advanced Reactor Technology Resource Integration Committee
- Engaged with Clear Path, Third Way and Clean Air Task Force

Supporting Information

NuScale Technology Overview

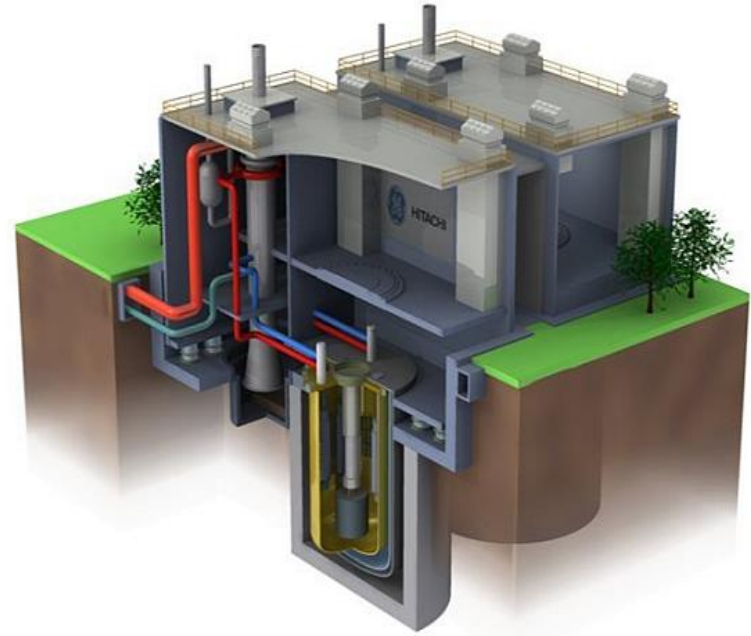
- Integrates reactor vessel, steam generator and high-pressure steel containment
- Recipient of significant funding by DOE
- Designed as dual “six-packs” of 60MWe reactors for total output of 720MWe



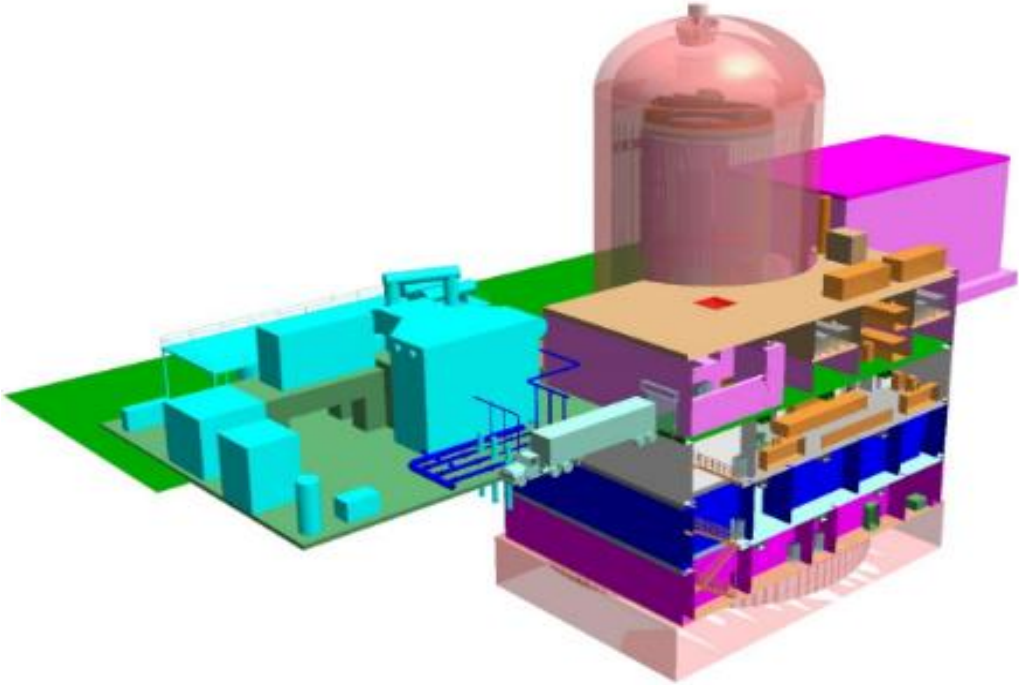
- Mature design with NRC review of Design Certification application under review and on schedule
- MOU with UAMPS and Idaho National Lab to construct plant at INL, financial investment decision by UAMPS under consideration
- Selected by TVA as design for potential plant at Clinch River site

GEH BWRX-300 Technology Overview

- 300MWe output
- Natural circulation
- Isolation condenser system cooling
- Early stages of design, but based on technology of NRC approved ESBWR

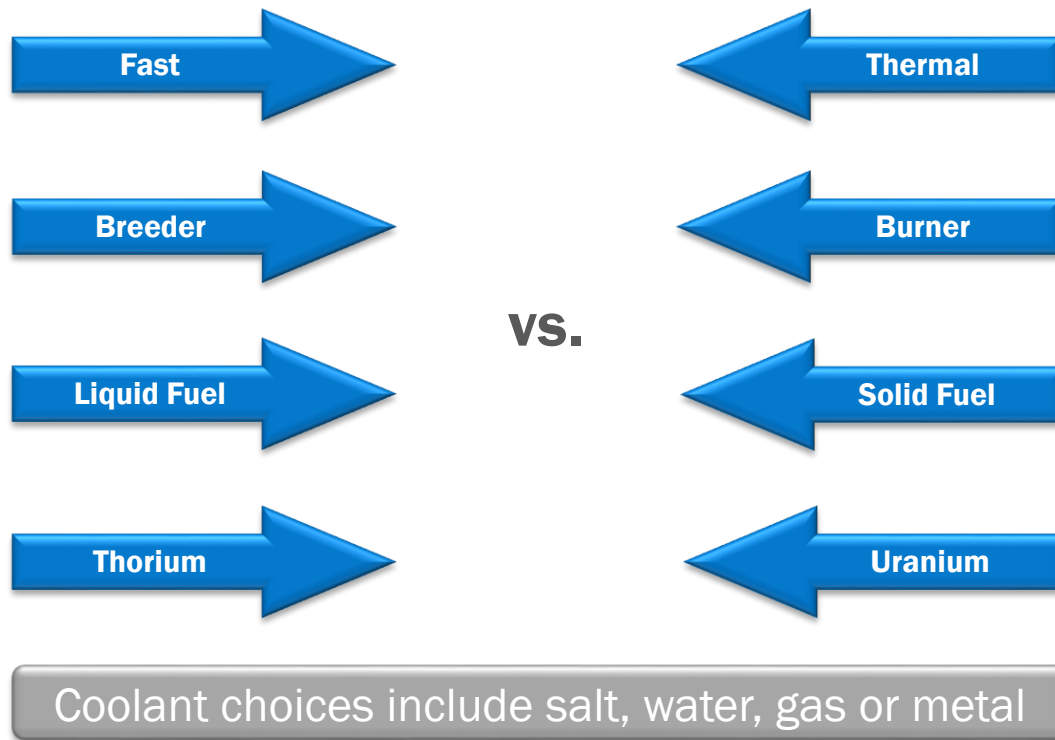


Holtec SMR-160 Technology Overview

- 160MWe output
 - Pursuing licensing by Canadian Nuclear Safety Commission
 - No boric acid
 - Passive containment cooling
- 
- The diagram illustrates the Holtec SMR-160 reactor system. It features a large, red, dome-shaped containment vessel on the right, which houses the reactor core. To the left of the containment vessel is a blue, rectangular structure representing the steam generator. The entire system is housed within a multi-story building with a yellow roof and blue walls. The building is shown in a cutaway view, revealing internal components and piping. The reactor is situated on a green base, and the entire system is surrounded by a blue area representing water or a cooling pond.
- ExGen signed an MOU with Holtec, joining SNC-Lavalin and Mitsubishi Electric on the Holtec SMR team
 - Energoatom (Ukraine's national nuclear generator) announced plans to establish a "consortium" with Holtec to explore the environmental and technical feasibility of an SMR-160 system

Advanced Reactors

- Output ranges from 1MWe to gigawatt size
- Generally, “advanced reactor” refers to a design using a different fuel form, coolant and/or moderator as compared to current fleet



Advanced Reactor Categories (Representative Examples)

High Temperature

- X-energy
- Areva
- Urenco U Battery
- Kairos Power

Molten Salt

- Terrestrial Energy
- FLiBe
- Elysium
- Terra Power

Liquid Metal

- GEH PRISM
- Westinghouse
- Oklo
- Advanced Reactor Concepts

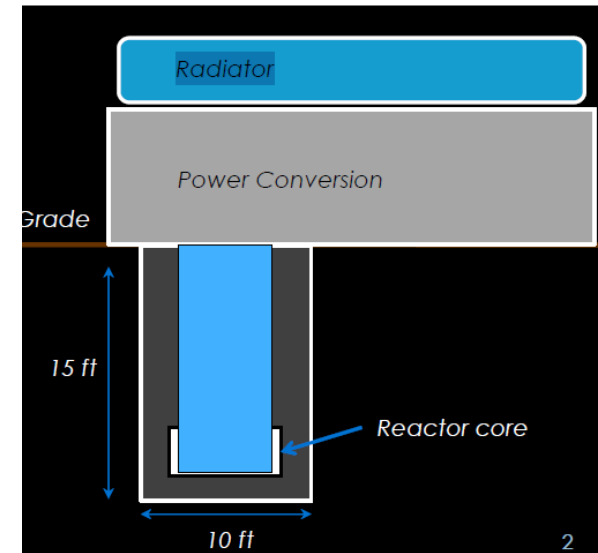
Fusion

- Tri-Alpha
- Helion
- Lockheed Martin
- Commonwealth Fusion

- Significant effort underway to reform current regulatory framework to accommodate new designs
- Developers range from small startup companies to large, established entities

Microreactors

- Generally, 1MWe to 10MWe
- Designed to replace diesel-powered electricity in remote areas
- Designs span multiple types including light water cooled, gas cooled and molten salt
- Recent interest by DOD for deployment at permanent installations and mobile sites



- Most require U enrichment $>5\%$ but $<20\%$ allowing for 10-12 operation without offsite fuel supply
- Leading developers include: Oklo, X-energy, WEC, Elysium, Flibe and Urenco